TIDES OF HOBSON'S BAY

By J. E. Bradley, L.S., F.V.I.S.

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Abstract

The data available on the tides of Hobson's Bay are reviewed. The results of harmonic analysis of the records are given and predictions based on these are compared for the year 1946. The tides of Williamstown are compared with those at Port Port Phillip Heads and at Victoria Dock. Data are given on mean tide level and mean high and low water for Hobson's Bay.

Tidal Observations

From January 1874 until it closed down in September 1943 the Melbourne Observatory maintained records of the tides at Williamstown. On 30 August 1943 these records were handed over to the Melbourne Harbor Trust Commissioners together with the self-registering tide gauge situated in a small stone house at the shore end of the Breakwater Pier, Williamstown. The records have been kept up-to-date since they were taken over, and the times and heights of each successive high water are tabulated in a book of convenient form.

The heights of tides are referred to Admiralty Chart Datum, determined as Low Water Springs by Captain Cox, R.N., about 1864 when making the original survey for what is now called Chart 624 Hobson's Bay. This chart datum is Reduced Level 0·19 on the Melbourne and Metropolitan Board of Works Datum for Levels. The Reference Bench Mark used for setting the tide gauge is a broad arrow on the sill of the old Williamstown Lighthouse (later used as a Time Ball tower and now again as a lighthouse). This bench mark is 7·81' above M.M.B.W. Datum.

Soon after the transfer of the self-registering tide gauge to the Harbor Trust Commissioners it was found that siltation in the vicinity of the gauge well was preventing free access of water to the well. This was causing the gauge to register low waters too high and high waters too low by an average amount of about 4″. As dredging of the site was not possible it was decided to remove the gauge to Ann Street Pier, where no trouble from siltation is expected.

Tidal Predictions

Before 1945 the only locally published predictions for Williamstown were those computed and published by the Ports and Harbours Branch of the Department of Public Works from a table of Lunitidal Intervals applied to the time of the moon's meridian passage. No heights were

tabulated. The original table of Lunitidal Intervals was computed by Mr. E. J. White of the staff of the Melbourne Observatory and was based on continuous tidal records for the periods 1 August 1875 to 31 July 1876, and 1 January 1886 to 18 June 1887.

TABLE 1

LIVERPOOL OBSERVATORY AND TIDAL INSTITUTE

LIST OF HARMONIC CONSTANTS

Place: Melbourne (Williamstown)

Latitude	Longitude L	Standard Time S	Records	
			Length	Central Day
37° 52′ S.	144° 55′ E.	−10	1 Year	March 1, 1944

Constants from hourly tide-gauge readings, Breakwater Pier Signal Station. Zero of tide-gauge is RL. 0·19 M.M.B.W. datum.

For predictions:

A_0 : 1·387 ft. (M.T.L. for 17 years, corrected).
Sa : ·098, 091° ⎫ Mean of M.S.L. for 17 years.
Ssa : ·108, 152° ⎭

	H	g		H	g		H	g		H	g
A_0	1·543	—	$2Q_1$	·008	346·0	OQ_2	·015	199·6	MO_3	·035	166·7
Sa	·274	001·7	σ_1	·013	138·0	MNS_2	·007	045·0	M_3	·003	251·7
Ssa	·128	075·4	Q_1	·047	087·6	$2N_2$	·033	345·9	SO_3	—	—
Mm	·092	145·7	ρ_1	·014	077·9	μ_2	·034	084·9	MK_3	·023	208·9
MSf	·067	180·9	O_1	·226	096·1	N_2	·125	014·4	SK_3	·014	355·9
Mf	·007	278·1	MP_1	·022	087·4	ν_2	·036	004·8			
			M_1	·007	098·1	OP_2	·012	160·1	MN_4	·008	060·2
			X_1	·012	055·0	M_2	·772	063·9	M_4	·021	095·4
			π_1	·014	210·2	MKS_2	·004	045·0	SN_4	·004	194·0
			P_1	·090	134·4	λ_2	·004	166·0	MS_4	·011	217·9
			S_1	·038	118·7	L_2	·073	099·4	MK_4	·008	194·0
			K_1	·285	134·7	T_2	·014	210·2	S_4	·007	033·7
			ψ_1	·015	301·8	S_2	·181	197·6	SK_4	·002	090·0
			ϕ_1	·011	174·8	R_2	·004	090·0			
			θ_1	·005	158·2	K_2	·037	202·2	$2MN_6$		
			J_1	·017	170·0	MSN_2	·015	070·4	M_6		
			SO_1	·024	087·6	KJ_2	·008	240·2	MSN_6		
			OO_1	·012	311·7	$2SM_2$	·009	139·4	$2MS_6$		
									$2MK_6$		
									$2SM_6$		
									MSK_6		

Various harmonic analyses have been made (see Table 4 below).

At the request of the Melbourne Harbor Trust Commissioners an harmonic analysis of records for one year was made by the Liverpool Observatory and Tidal Institute. The records analysed were for the period 1 September 1943 to 31 August 1944, hourly heights over this

period being obtained visually from a gauge located at the Signal Station at the outer end of the Breakwater Pier, Williamstown, and so constructed that oscillations are damped out. The results of this analysis are shown in Table 1.

The Liverpool Observatory and Tidal Institute now supply predictions annually to the Melbourne Harbor Trust. The predictions of

TABLE 2

WILLIAMSTOWN, 1946

COMPARISON OF M.H.T. PREDICTED HEIGHTS WITH OBSERVED HEIGHTS
AT HIGH AND LOW WATERS

Difference between Predicted and Actual Height	Number of Tides													
	J.	F.	M.	A.	M.	Ju.	Jy.	A.	S.	O.	N.	D.	Total	Per cent of Whole
0″ — 3″ ..	14	34	50	56	62	57	30	51	47	64	51	59	575	40·78
3″ — 6″ ..	37	44	38	38	39	25	19	21	43	35	51	35	425	30·14
6″ — 12″ ..	46	24	18	20	12	26	32	32	18	19	13	15	275	19·50
12″ — 18″ ..	22	5	12	2	5	4	25	12	6	2	1	4	100	7·09
18″ — 24″ ..	—	1	2	—	2	4	13	3	2	—	—	7	34	2·41
24″ — 30″ ..	—	—	—	—	—	—	1	—	—	—	—	—	1	0·08
Total Tides	119	108	120	116	120	116	120	119	116	120	116	120	1410	100·00

TABLE 3

NUMBER OF HIGH TIDES (UPPER FIGURE) AND LOW TIDES (LOWER FIGURE)
WHICH FELL LOWER THAN PREDICTED

Predicted height – Actual height	Number of Tides												
	J.	F.	M.	A.	M.	Ju.	Jy.	A.	S.	O.	N.	D.	Total
0″ — 3″ ..	2	—	3	2	9	21	8	8	14	15	19	13	114
	—	2	2	5	21	9	3	11	14	15	15	14	111
3″ — 6″ ..	1	1	—	4	2	3	3	1	9	3	4	2	33
	—	2	—	—	4	12	6	5	11	6	11	4	61
6″ — 12″ ..	1	3	—	—	—	9	—	—	5	1	5	—	24
	1	4	—	—	—	9	1	1	4	4	4	—	28
12″ — 18″ ..	—	—	—	—	—	—	—	—	—	—	—	—	0
	—	—	—	—	—	—	—	—	—	—	1	—	1
Total { High / Low	4	4	3	6	11	33	11	9	28	19	28	15	171
	1	8	2	5	25	30	10	17	29	25	31	18	201
Max. possible { High / Low	60	54	60	58	60	58	60	60	58	60	58	60	706
	59	54	60	58	60	58	60	59	58	60	58	60	704

times and heights of all high and low waters for the year are published, with other Port data, for sale to the public.

A comparison of the heights predicted for 1946 with those which actually occurred is shown in Table 2.

Table 3 shows for 1946 the number of high and low tides which fell lower than predicted and the amount of the differences.

The times of tides are, generally speaking, within half an hour of that predicted except under very adverse weather conditions, but even then the times are never much out, alteration in water level being the principal effect.

Table 4 compares the values of the four main tide-producing components obtained by various harmonic analyses. There would appear to have been no change in the tidal constituents for Hobson's Bay since 1894, the earliest date for which data has been analysed.

TABLE 4

COMPARISON OF RESULTS OF VARIOUS HARMONIC ANALYSES

	M_2		S_2		K_1		O_1		A_0
—	g (°)	H(ft.)	g (°)	H(ft.)	g (°)	H(ft.)	g (°)	H(ft.)	
Admiralty— 31/3/09–31/3/11 ..	069	0·81	174	0·10	137	0·29	089	0·22	1·80
U.S. Coast and Geodetic survey. 1 month, May, 1894	069	0·81	164	0·10	132	0·29	095	0·22	—
J. E. Bradley, M.H.T.— 1943	062	0·75	200	0·16	174	0·24	106	0·21	1·40
Cdr. K. E. Oom, R.A.N.— 1944	064	0·76	201	0·13	143	0·27	108	0·18	1·40
Liverpool T.I., 1944— 1 yr., hourly hts., Central day, 1/3/44 ..	063·9	0·772	197·6	0·181	134·7	0·285	096·1	0·226	1·387
	Mean Lunar Semi-diurnal		Mean Solar Semi-diurnal		Lunar Solar Diurnal		Lunar Declina-tional Diurnal		

Relation to Tides of Port Phillip Bay

The tide is propagated from Bass Strait into Hobson's Bay via the Heads and Port Phillip Bay. Fig. 1 is an outline chart indicating very approximate co-tidal lines showing how the crest of the tide wave travels in Port Phillip Bay. As this is based on very little data taken from General Notice to Mariners, further observations might lead to alterations in this chart.

Generally speaking it is high water in Hobson's Bay between $2\frac{1}{2}$ and $3\frac{1}{2}$ hours after it is high water at Port Phillip Heads. The amplitude of the tide wave undergoes diminution after passing through the Heads. Fig. 2 shows the extent of this diminution and the time lag between the Heads and Williamstown.
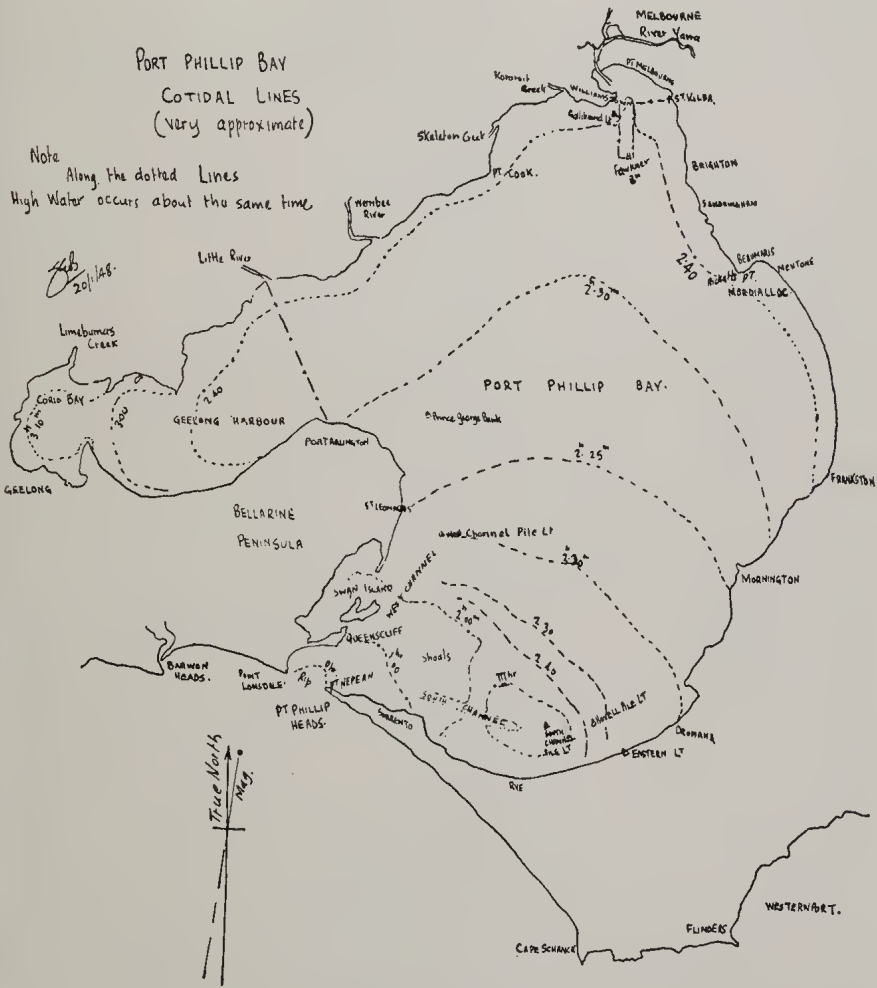

FIG. 1.—Cotidal Lines, Port Phillip Bay.

Mean Values

Table 5 shows the mean monthly range of tides at Williamstown since 1894. Records are not complete but are sufficient to show that little change in mean range has taken place.
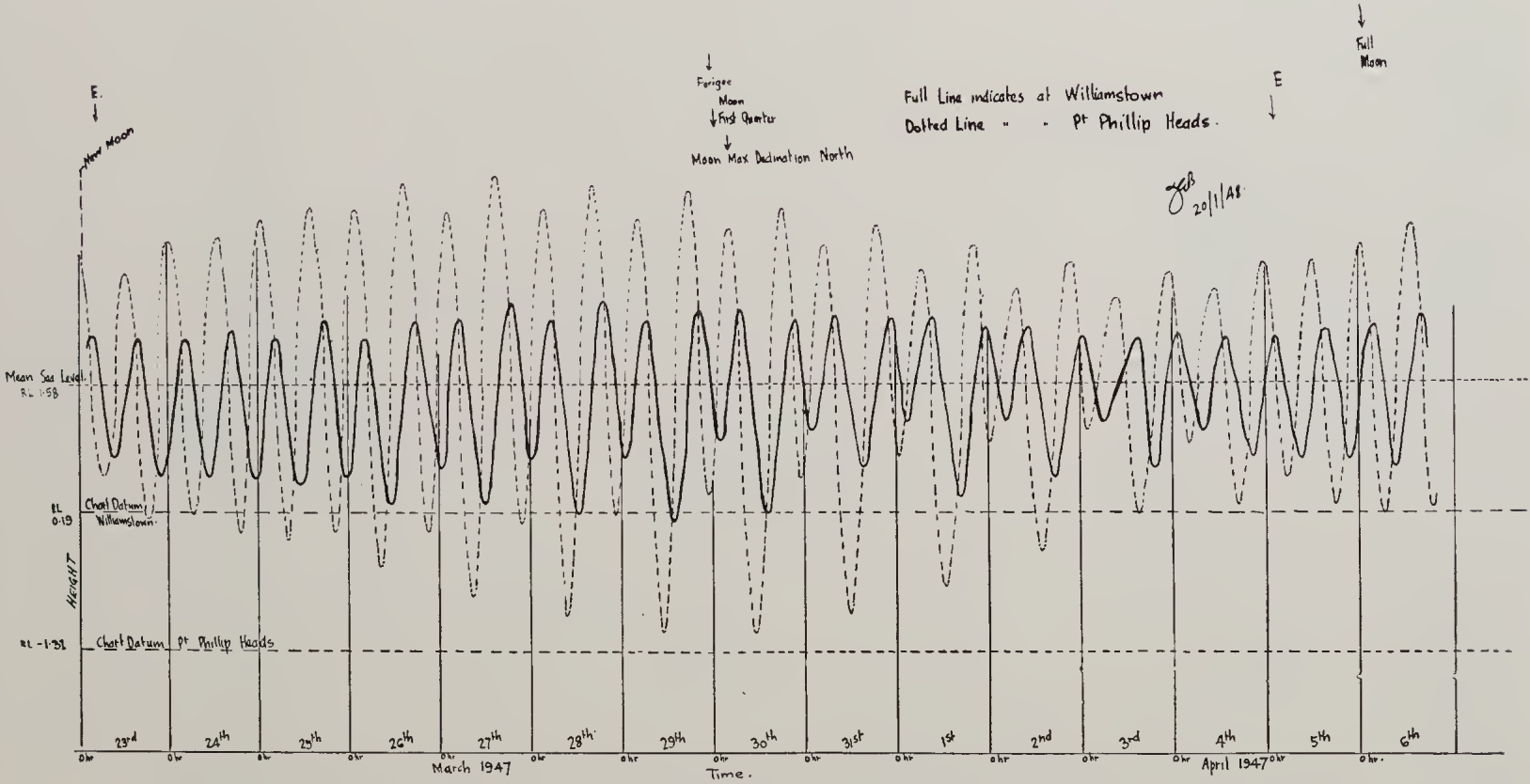
FIG. 2.—Typical Tidal Curves, Port Phillip Heads and Williamstown.

TABLE 5

MEAN MONTHLY RANGES OF TIDES AT WILLIAMSTOWN

Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1894 ..	—	—	—	—	—	—	1·66	1·66	1·69	1·70	1·68	1·64	1·67
1895 ..	1·62	1·61	1·69	1·67	1·62	1·63	1·64	1·63	1·63	1·63	1·61	1·70	1·64
1896 ..	1·66	1·70	1·67	1·59	1·66	1·56	1·63	1·49	1·62	1·67	1·64	1·67	1·63
1897 ..	1·65	1·68	1·63	1·53	1·58	1·59	1·57	1·58	1·64	1·75	1·67	1·70	1·63
1898 ..	1·75	1·68	1·63	1·62	1·60	1·61	1·65	1·58	1·82	1·70	1·70	2·03	1·69
1899 ..	1·66	1·65	1·66	1·63	1·61	1·62	—	—	—	—	—	—	1·64
					1900–1915 NOT COMPUTED								
1916 ..	1·71	1·69	1·64	1·67	1·64	1·68	1·65	1·64	1·64	1·67	1·74	1·74	1·68
1917 ..	1·71	1·71	1·77	1·57	1·64	1·67	1·67	1·63	1·70	1·74	1·67	1·67	1·68
1918 ..	1·68	1·71	1·71	1·63	1·62	1·63	1·68	1·69	1·72	1·68	1·62	1·78	1·68
1919 ..	1·71	1·60	1·62	1·68	1·60	1·65	1·63	1·61	1·65	1·61	1·62	1·66	1·64
1920 ..	1·66	1·66	1·68	1·61	1·62	1·69	1·64	1·62	1·60	1·71	1·64	1·65	1·65
1921 ..	1·68	1·66	1·68	1·62	1·60	1·58	1·63	1·65	1·63	1·63	1·66	1·63	1·64
1922 ..	1·67	1·66	1·64	1·57	1·67	1·58	1·60	1·64	1·56	1·66	1·62	1·64	1·63
1923 ..	1·67	1·62	1·57	1·59	1·68	1·64	1·64	—	1·68	1·64	1·64	1·63	1·64
1924 ..	1·62	1·69	1·64	1·57	1·56	1·59	1·56	1·58	1·55	1·63	1·62	1·63	1·60
1925 ..	1·66	1·59	1·58	1·61	1·54	1·56	1·55	1·57	1·57	1·51	1·53	1·57	1·65
1926 ..	1·59	1·64	1·59	1·60	1·62	1·63	1·58	1·56	1·60	1·58	1·60	1·57	1·59
1927 ..	1·55	1·58	1·54	1·50	1·52	1·52	1·55	1·56	1·59	1·58	1·54	1·60	1·55
1928 ..	1·63	1·58	1·55	1·56	1·43	1·52	1·50	1·47	1·48	1·55	1·53	1·57	1·53
1929 ..	1·63	—	1·55	1·52	1·48	1·56	1·59	1·53	1·49	1·49	1·53	1·57	1·54
1930 ..	1·55	1·66	1·50	1·68	1·50	1·55	1·54	1·52	1·49	1·41	1·51	1·58	1·54
1931 ..	1·52	1·52	1·48	1·52	1·63	1·50	1·60	1·51	1·52	1·47	1·52	1·49	1·52
1932 ..	1·50	1·55	1·54	1·47	1·43	1·51	1·44	1·49	1·45	1·47	1·49	1·57	1·49
1933 ..	1·47	1·43	1·49	1·44	1·39	1·46	1·42	1·39	1·40	1·45	1·48	1·52	1·44
1934 ..	1·54	1·48	1·47	1·47	1·46	1·48	1·53	1·50	1·53	1·48	1·51	1·50	1·49
1935 ..	1·56	1·53	1·54	1·56	1·58	1·53	1·49	1·49	1·43	1·44	—	1·55	1·52
1936 ..	1·49	1·46	1·53	1·49	1·42	1·34	1·47	1·46	1·43	—	—	—	1·45
					1937–1942—NO RECORDS AVAILABLE								
1943 ..	From Signal	M.H. T, visual gauge hourly heights Station, Breakwater Pier							1·71	1·67	1·79	1·79	1·74
1944 ..	1·87	1·83	1·83	1·79	1·73	1·64	1·69	1·83	1·69	1·75	1·77	1·85	1·77
1945 ..	1·77	1·75	1·77	1·73	1·71	1·67	1·73	1·72	1·75	1·77	1·71	1·77	1·74
1946 ..	1·75	1·79	1·71	1·71	1·71	1·69	1·72	1·72	1·64	1·69	1·69	1·71	1·71
1947 ..	1·77	1·67	1·75	1·73	1·67	1·67	1·73	1·67	1·67	1·71	1·69	1·73	1·77

April, 1894. Side of tide gauge well broken open to clear mud, and after this gauge appears to have been in order until 1930.

It appears that from 1930 onwards the gauge began to be affected by siltation outside the well, not allowing a full range. This agrees with what Lieut. W. H. Martin, R.A.N., stated about this time when he was surveying Hobson's Bay.

J. E. Bradley:

Table 6 shows data about mean tide level. This has considerable variation, mainly due to meteorological conditions.

TABLE 6

MEAN TIDE LEVEL

Heights of Mean Tide Level at Williamstown above Admiralty Chart Datum RL 0·19 based on the mean of all High and Low Waters (not hourly heights) taken from Automatic Gauge Records.

Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1894 ..	—	—	—	—	—	—	1·81	1·40	1·24	1·36	1·52	1·20	—
1895 ..	1·18	1·16	1·27	1·33	1·48	1·69	1·60	1·66	1·66	1·50	1·29	1·83	1·47
					1896–1915 NOT COMPUTED								
1916 ..	1·29	1·12	1·10	1·63	1·56	1·75	1·45	1·01	1·13	1·33	1·67	1·48	1·38
1917 ..	1·54	1·25	1·70	1·52	1·94	1·68	2·12	1·37	1·68	1·62	1·35	1·40	1·59
1918 ..	1·14	1·12	1·27	1·08	1·70	1·96	1·52	1·24	1·24	1·42	1·19	1·40	1·36
1919 ..	1·39	0·98	1·31	1·12	1·16	1·77	1·42	1·26	1·44	1·30	0·98	1·17	1·28
1920 ..	0·67	1·11	1·27	1·22	1·49	1·86	1·56	1·42	1·16	1·20	1·28	1·38	1·30
1921 ..	1·14	1·18	1·25	1·52	1·24	1·43	1·86	1·41	1·40	1·28	1·53	1·18	1·37
1922 ..	1·42	1·45	1·26	1·66	1·62	1·52	1·34	0·84	0·50	0·87	0·96	1·59	1·25
1923 ..	1·90	1·27	1·31	0·81	2·26	1·80	1·67	1·34	1·63	1·51	1·55	1·25	1·52
1924 ..	1·65	1·46	1·34	1·62	1·52	1·64	1·28	1·38	1·49	1·77	1·72	1·36	1·52
1925 ..	1·23	1·56	1·20	1·31	1·14	1·22	1·56	1·27	1·41	1·34	0·98	1·25	1·29
1926 ..	1·09	1·49	1·13	1·62	1·54	1·61	1·60	1·71	1·09	1·87	1·60	1·35	1·47
1927 ..	1·23	1·52	1·38	1·29	1·66	1·33	1·50	1·56	1·01	1·09	1·12	1·34	1·33
1928 ..	1·16	1·25	1·22	1·61	1·42	1·47	1·62	1·44	1·95	1·94	1·55	1·37	1·50
1929 ..	1·84	1·28	1·36	1·73	1·56	1·60	1·31	1·16	1·01	1·11	1·24	1·61	1·40
1930 ..	1·16	1·10	0·93	1·19	1·22	1·11	1·67	1·58	1·60	1·23	1·08	1·64	1·29
Mean for 16 years	1·31	1·27	1·27	1·33	1·53	1·59	1·67	1·35	1·33	1·39	1·33	1·40	1·40
1944 ..	1·79	1·69	1·75	2·00	1·95	1·50	1·50	1·15	1·27	1·60	1·83	2·23	1·69
1945 ..	1·93	1·77	1·75	1·35	1·73	1·67	1·48	1·91	1·79	1·62	1·81	1·58	1·70
1946 ..	1·96	1·62	1·71	1·67	1·79	1·67	2·25	1·83	1·37	1·46	1·33	1·69	1·69
1947 ..	1·58	1·31	1·73	1·50	1·90	2·10	2·08	1·67	1·60	1·73	1·42	1·62	1·44
Mean Barometer (inches)	29·913	29·962	30·037	30·101	30·106	30·078	30·097	30·067	29·996	29·965	29·952	29·896	30·014
Mean Evaporation (ft.)	0·53	0·42	0·32	0·19	0·12	0·09	0·09	0·12	0·18	0·27	0·37	0·47	3·17

Table 7 shows information about mean high water and mean low water, Hobson's Bay. These heights would be of value in determining the 'shore' in relation to littoral lands. As the shore is that strip of land situated between these limits, it is the area lying between contour R.L. 1·00 and contour R.L. 2·76.

TABLE 7.—BREAKWATER PIER, WILLIAMSTOWN
MEAN HIGH WATER

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1944	2·73	2·58	2·67	2·90	2·81	2·31	2·33	1·98	2·12	2·50	2·73	3·12	2·57 = R.L.2·76
1945	2·83	2·61	2·62	2·21	2·58	2·50	2·35	2·75	2·67	2·52	2·67	2·48	2·57
1946	2·83	2·50	2·58	2·50	2·65	2·50	3·10	2·67	2·19	2·29	2·17	2·54	2·54
1947	2·46	2·14	2·60	2·50	2·73	2·96	2·94	2·50	2·42	2·60	2·27	2·48	2·55

MEAN LOW WATER

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1944	0·83	0·79	0·83	1·10	1·08	0·67	0·67	0·31	0·42	0·77	0·95	1·31	0·81 = R.L.1·00′
1945	1·02	0·89	0·87	0·50	0·87	0·81	0·69	1·02	0·93	0·75	0·96	0·71	0·83
1946	1·10	0·71	0·83	0·83	0·96	0·81	1·37	0·98	0·54	0·60	0·48	0·83	0·82
1947	0·71	0·48	0·85	0·58	1·04	1·25	1·21	0·83	0·77	0·85	0·56	0·75	0·82

Mean Sea Level is 1·387′ above chart datum and Indian Spring Low water is 0′ 1″ below chart datum.

Record tides at Hobson's Bay are:

  Highest: 1 December 1934—6′ 6″ above chart datum;
  Lowest: 19 September 1926—1′ 4½″ below chart datum;
       i.e., maximum range 7′ 10½″.

There is little difference in time and height of high and low water at Victoria Dock and Williamstown. A comparison for each hour for 29 days (central day 13 October 1943) gives results shown in Table 8.

TABLE 8

COMPARISON OF HOURLY READINGS, VICTORIA DOCK AND WILLIAMSTOWN, FOR 29 DAYS

Difference in water level (ft.)	Number of Observations	Percentage
0	286	41·09
·1	270	38·79
·2	99	14·23
·3	26	3·74
·4	9	1·29
·5	—	—
·6	4	·57
·7	—	—
·8	2	·29
	696	100·00

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Acknowledgment

I wish to thank the Chairman and Commissioners of the Melbourne Harbor Trust for making available much of the information set out in this paper.

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